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Standard Method of Test for
VISCOSITY OF PAINTS, VARNISHES, AND LACQUERS BY FORD VISCOSITY CUP[1]

This Standard is issued under the fixed designation D 1200; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method covers the determination of the viscosity of paints, varnishes, lacquers, and related liquid materials with the Ford-type efflux viscosity cup.

1.2 The cup-orifice combination (Ford No. 2, No. 3, or No. 4) is selected to provide an efflux time within the range 20 to 100 s. When the time of efflux is beyond this range, accurate temperature control is difficult. Any wide departure from Newtonian behavior might result in a lack of reproducibility because of the difficulty of judging the break in the stream.

2. Summary of Method

2.1 The Ford viscosity cup is filled level full with the liquid to be tested; then the time of efflux of the material is measured.

3. Apparatus

3.1 *Ford Viscosity Cup*—The No. 2, No. 3, and No. 4 Ford viscosity cups shall be made of corrosion- and solvent-resistant materials, assembled as complete units (Note 1), and conform to the dimensional requirements shown in Fig. 1. The orifice dimensions shall be considered as a guide for manufacture only and standardization of the instruments shall be based upon the calibration procedure described in the Appendix.

Note 1—If the orifice is removed from the cup for any reason the cup should be recalibrated before use as described in the Appendix.

3.2 *Thermometer*—An ASTM Saybolt Viscosity Thermometer having a range of from 19 to 27 C and conforming to the requirements for Thermometer 17C or 17F (66 to 80 F) as prescribed in ASTM Specification E1, for Thermometers.[2]

3.3 *Time*—The stop watch or other timing device shall be graduated in divisions of 0.2 s or less, and shall be accurate to within 3.6 s as compared to an electric clock operated on a standard 60-H current for a period of 1 h.

Note 2—Timing devices actuated by synchronous motors may be used on electric circuits of controlled frequency only if they are accurate and capable of being read to 0.2 s.

4. Test Sample

4.1 The sample of the material to be tested shall be visibly homogeneous and free of any foreign material or air bubbles.

5. Temperature of Testing

5.1 All measurements with the Ford viscosity cup shall be made at 25 ± 0.1 C (77 ± 0.2 F) and temperature drift during the test shall not exceed 0.1 C (0.2 F) as determined by a thermometer in the efflux stream.

Note 3—It is impossible to predict the effect of temperature change on each product with which the apparatus may be used. This factor may be less than 1 percent per degree Celsius for some liquids while others may be considerably higher.

6. Calibration

6.1 Cups should be calibrated in accordance with the procedure described in the Appendix. The frequency of this calibration check would depend upon the amount of use and the care that the individual cup receives. If the cup varies more than 10 percent from standard, it should not be used.

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[1] This method is under the jurisdiction of ASTM Committee D-1 on Paint, Varnish, Lacquer and Related Products.

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[2] *1973 Annual Book of ASTM Standards*, Part 30.

7. Conditioning

7.1 Since most materials are non-Newtonian in nature it is necessary to establish an agitation and rest period history before the viscosity determination is made.

7.2 Bring the material to a temperature a few degrees below that desired and then agitate vigorously on a reciprocating shaker in a pint can ⅔ full for 10 min. Allow to stand undisturbed while adjusting further to the desired temperature. Make the viscosity determination at end of the 10-min period.

8. Procedure

8.1 Make viscosity determinations in a room free from drafts and rapid changes in temperature. For the highest degree of accuracy the room temperature should be between 20 and 30 C (68 and 86 F). Determinations should be made at a temperature below the dew point of the atmosphere surrounding the apparatus.

8.2 Choose the proper cup so that the time of efflux will be between 20 and 100 s for cups No. 3 and 4 and between 40 and 100 s for cup No. 2 (Fig. 2).

8.3 Level the instrument so that the cup may be filled level full without meniscus or overflow at one side.

8.4 Determine the time in seconds of efflux as follows: Close the orifice with the finger and fill the cup with the prepared sample. The preferred method is to overfill the cup and scrape off the excess with a straightedge. Measure the time from the moment efflux starts until the first break in the stream.

8.5 If the cup has been established to be nonstandard when calibrated as described in the Appendix, apply the percentage difference to the measured seconds in order to get the correct viscosity in Ford cup seconds.

9. Care of Cup

9.1 Following each determination, clean the cup by the use of a suitable solvent and a soft brush. Under no conditions should metal cleaning tools be brought into contact with the instrument. Particular care must be exercised in cleaning the orifice to avoid any film deposit or nicks on the inside walls.

10. Report

10.1 Report the efflux time to the nearest 0.2 s for the cup orifice combination (for example, Viscosity 23.2 s with No. 4 Ford cup), the temperature as measured in the efflux stream, and the immediate history of agitation and rest prior to the measurement.

11. Precision

11.1 On the basis of a study in which eight cooperators from six different laboratories compared measurements of oils ranging in viscosity from 35 cSt to 130 cSt, using each of these cups, the standard deviations between laboratories was less than 2 percent for all the cups, and the standard deviation within laboratories was less than 0.5 percent.

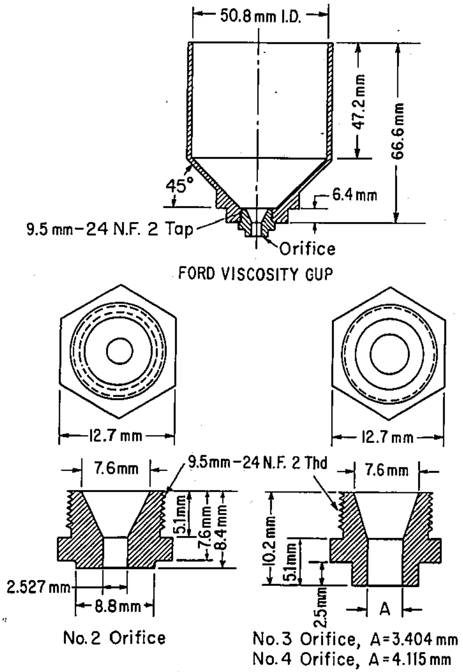

FIG. 1 Ford Viscosity Cup and Orifices.

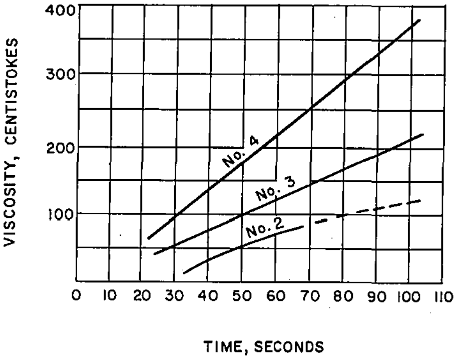

FIG. 2 Approximate Viscosity Curves for Ford Cups.

APPENDIX

A1. CALIBRATION PROCEDURE FOR FORD CUPS

A1.1 The orifice of the Ford cup is commonly made of brass or some other corrosion-resistant material which is subject to wear with use and cleaning. A small change in diameter of the orifice becomes significant in the results obtained with the use of this type of viscosity-measuring apparatus.

A1.2 Certified kinematic viscosity standards are available from the Cannon Instrument Co., P.O. Box, State College, Pa. 16801 (Note A1). For particular oils applicable use with the Ford Cups refer to Table A1. Oils available from other sources, having known kinematic viscosities, may also be used.

NOTE A1—The viscosity standards are available only as 1-pt samples.

A1.3 Select the appropriate liquid viscosity standard for the cup to be calibrated. Bring this cup and the liquid viscosity standard to a constant temperature of 25 ± 0.1 C (77 ± 0.2 F). Determine the time of efflux to the nearest 0.2 s using the procedure detailed in Section 8, ensuring that the temperature of the cup and liquid remain within the above limits during the time of flow as determined by a thermometer in the efflux stream.

A1.4 The following formulae are used to convert the time of flow in seconds to kinematic viscosity:

$$\text{Centistokes (No. 2 orifice)} = 2.388t - 0.007t^2 - 57.008$$

$$\text{Centistokes (No. 3 orifice)} = 2.314t - 15.200$$

$$\text{Centistokes (No. 4 orifice)} = 3.846t - 17.300$$

where t = temperature, deg C.

A1.5 The difference between the certified viscosity and the determined viscosity, multiplied by 100 and divided by the certified viscosity will give the percentage variation of the cup from standard. A percentage correction can be applied to the seconds flow when the cup is in normal use. If the cup varies more than 10 percent from standard, it is recommended that the orifice be replaced and that the cup be recalibrated.

TABLE A1 Viscosity Standards Recommended for Calibrating Ford Vicsosity Cups

Cup Number	Range, cSt	Standard Designation	Designated Viscosity at 25 C (77 F)[a], cSt
2	25 to 120	S-20	35
3	40 to 220	S-60	120
4	70 to 370	S-60	120

[a] Exact viscosities are supplied with the oil samples.

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